Toshiba Cera

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the manner of support of the silicon wafer by the vertical-mold wafer boat for processing two or more semiconductor wafers with a vertical-mold heat treating furnace in more detail about the manner of support of a silicon wafer in the manufacturing process which heat-treats a silicon wafer.
[0002]
[Description of the Prior Art] Generally, in order to manufacture a silicon wafer, many heat treatment processes were needed for processings, such as oxidization diffusion and a deposit, and the heat treating furnace of a horizontal type has mainly been used in heat treatment of the silicon wafer to the diameter of 6 inches. However, with diameter[of macrostomia]-izing of a silicon wafer, heat-treating-furnace composition members, such as a silicon wafer, a reactor core tube, and a vertical-mold wafer boat, become heavy, and it may be unable to use [the aforementioned composition member may be unable to cause a heat creep etc. and] it, and the heat treating furnace of a vertical mold came to be widely used in recent years. And in this vertical-mold heat treating furnace, the vertical-mold wafer boat which loads two or more semiconductor silicon wafers into lengthwise is used.
[0003] Two or more silicon wafer insertion slots are formed in a longitudinal direction with a predetermined interval, and the vertical-mold wafer boat used for the aforementioned vertical-mold heat treating furnace is constituted by the silicon wafer supporter material arranged around a silicon wafer lengthwise, and the support plate which fixes the vertical both ends of the aforementioned silicon wafer supporter material, as shown in JP,60-107843,A, JP,3-295227,A, etc.
[0004]
[Problem(s) to be Solved by the Invention] By the way, since the silicon wafer inserted in the vertical-mold boat is usually supported by the silicon wafer supporter of several points as mentioned above and balances the self-weight of a silicon wafer in this portion, maximum stress generates it on the silicon wafer near [aforementioned] the supporter. Moreover, a silicon wafer receives thermal stress by the temperature gradient within a silicon wafer side at the time of heat treatment while receiving the stress by self-weight from silicon wafer supporter material, as mentioned above.
[0005] and heat treatment with a vertical-mold heat treating furnace -- in process -- such stress -- lapping -- just -- being alike -- the shear-yield-stress value of the crystal of a silicon wafer may be exceeded When the aforementioned shear-yield-stress value is exceeded, crystal transposition arises in a silicon wafer and a silicon wafer is made to deform plastically (henceforth a slip). Consequently, while reducing the quality of a product, the technical technical problem that the yield of silicon wafer manufacture was decreased occurred.
[0006] In order that this application may solve the above-mentioned technical technical problem, a silicon wafer is made paying attention to the decomposition shearing stress on a sliding surface changing with the operation directions, even if the size of external force is the same, since it is formed with the single crystal of silicon. namely, -- It is because decomposition shearing stress on the sliding surface

about slip generating cannot be suppressed although the stress generated on a silicon wafer can be decreased only by having only increased the number of the supporter material which supports a silicon wafer, and supporting a silicon wafer in respect of a large number. Then, by decreasing the decomposition shearing stress which acts on the sliding surface of a silicon wafer, this application tries to suppress the slip generated in a silicon wafer.
[0007] the slip which generates the decomposition shearing stress which acts on the sliding surface of a silicon wafer in a silicon wafer by decreasing as this invention was mentioned above -- suppressing -- high yield **** in a silicon wafer heat treatment process -- it aims at offering the manner of support of the silicon wafer which can do things
[0008]
[Means for Solving the Problem] the straight line and parallel which connect two supporters which counter the [110] directions of a crystal in the manner of support of the silicon wafer in which the manner of support of the silicon wafer concerning this invention made in order to solve the aforementioned technical technical problem has the crystal face (100) in parallel with a wafer front face -- or it is characterized by arranging in two adjoining supporters, 45 degrees, and the direction to make, and supporting a wafer Moreover, it sets to the manner of support of the silicon wafer which has the crystal face (111) in parallel with a wafer front face. A symmetry axis is set as the diameter which passes along this supporter one vertex of the equilateral triangle inscribed in the periphery circle of the wafer which consists of the side parallel to [110], [101], and the [011] directions of a crystal together with one supporter. Other two vertices of the aforementioned equilateral triangle are arranged so that it may become symmetrical, and it is characterized by supporting a silicon wafer with the aforementioned supporter and other supporters formed with the interval of the multiple of 30 degrees. Furthermore, it is characterized by supporting the aforementioned silicon wafer by four with the interval of 90 degrees.
[0009]
[Function] A silicon wafer is supported as mentioned above Since the decomposition shearing stress tau expressed with tau=Fcos beta/(A/cosalpha) =sigmacosalphacosbeta can be stopped small, a shear-yield-stress value is not exceeded in the heat treatment process of a silicon wafer, crystal transposition does not arise in a silicon wafer, and generating of a slip can be prevented.
[0010]
[Example] First, the sliding surface and slip direction in Si crystal which constitutes a silicon wafer are considered. Si crystal consisted of a single crystal and the atomic arrangement has taken the atomic arrangement of a diamond type crystal. Therefore, the slip system, i.e., the sliding surface, and slip direction of a diamond type crystal have <110 {111}> as well as the face-centered cube type crystal. And as shown in Table 1, 12 slip systems equivalent in crystallography exist in the <110 {111}> slip systems of this face-centered cube type crystal.
[0011] Here, it is aforementioned <. The meaning of the sign of >, the sign of { } and ( ) used for behind, and [ ] is explained briefly. These signs are signs generally used in the crystallography, and [ ] expresses the direction of the vector from the arbitrary lattice points under crystal to other arbitrary lattice points P. That is, the arbitrary lattice points under crystal are made into Zero O, a crystallographic axis (direction) x, and y and z are taken (the side length of a unit lattice is a, b, and c), and Vector OP is expressed with ua+vb+wc when the vector from the aforementioned zero O to other arbitrary lattice points P is considered. This [uvw] is called crystal orientation.
[0012] Moreover, < > expresses the equivalent direction group. That is, if the array state of the surrounding atom in alignment with the crystal orientation [uvw] of Vector OP is seen, a symmetrical direction exists. These directions are mutually equivalent in crystallography, put these directions together and express them with <uvw>.
[0013] Moreover, ( ) is called Miller indices and expresses the crystal face containing the three lattice points in which it is [under crystal] different from each other. And the equivalent crystal face exists mutually in crystallography like [crystal face / this] the case of the above-mentioned direction. { } expresses by putting these equivalent crystal faces together.
[0014] In addition, although the negative component was generally expressed by lengthening a bar on a

number as shown in drawing of this application, in this specification, it was presupposed that it is expressed by lengthening an underline under a number.

[0015] Next, the <110 {111}> slip systems of the above-mentioned face-centered cube type crystal are concretely explained based on drawing 1 . As shown in drawing 1 , it is equivalent to {111} sides in crystallography, and that from which a direction differs exists with (111), (111), (111), and four (111). That is, the crystal face which the crystal face containing the three lattice points A, B, and C in which it is [under crystal] different from each other is expressed with (111), and contains the three lattice points B, C, and D is expressed with (111), and the three more lattice points and the crystal face containing C, D, and E are expressed with (111), and the three lattice points and the crystal face containing C, E, and A are expressed with (111). The atomic-arrangement state around these crystal faces of any crystal face, i.e., symmetric property, is completely the same, and it is equivalent. These crystal faces are mutually equivalent in crystallography, put these directions together and are expressed with {111}.

[0016] Here, generally a skid happens by the specific crystal face. This specific crystal face is called a sliding surface. Therefore, the sliding surface of a diamond type crystal is {111}.

[0017] Next, the slip direction in the aforementioned crystal face is examined. The slip direction in a crystal-face (111) side is considered. There is a direction to the lattice point C by making the lattice point A into a zero first, and this can be expressed with [011]. Moreover, there is a direction to the lattice point B by making the lattice point C into a zero, and this can be expressed with [101]. Furthermore, there is a direction to the lattice point A by making the lattice point B into a zero, and this can be expressed with [110]. As mentioned above, three directions, [110], [101], and [011], are included in a field (111). In order that a slip direction may be slippery in the above-mentioned direction, as for a slip direction, three directions exist to one sliding surface.

[0018] In addition, if the array state of the surrounding atom in alignment with [110] is seen, it is as symmetrical as [101] and [011]. These directions are mutually equivalent in crystallography, put these directions together and are expressed with <110>.

[0019] Similarly, the three <110> directions are included in each field also about three fields, (111), (111), and (111). Therefore, it turns out that in this face-centered cube type crystal 12 slip systems equivalent in crystallography exist as shown in Table 1.

[0020]

[Table 1]

No.	すべり面	すべり方向
1	(111)	$[1\underline{1}0]$
2	(111)	$[10\underline{1}]$
3	(111)	$[01\underline{1}]$
4	$(\underline{1}11)$	$[110]$
5	$(\underline{1}11)$	$[01\underline{1}]$
6	$(\underline{1}11)$	$[\underline{1}0\underline{1}]$
7	$(1\underline{1}1)$	$[\underline{1}\underline{1}0]$
8	$(1\underline{1}1)$	$[0\underline{1}\underline{1}]$
9	$(1\underline{1}1)$	$[10\underline{1}]$
10	$(\underline{1}\underline{1}1)$	$[\underline{1}10]$
11	$(\underline{1}\underline{1}1)$	$[\underline{1}0\underline{1}]$
12	$(\underline{1}\underline{1}1)$	$[0\underline{1}\underline{1}]$

[0021] Next, the relation between the decomposition shearing stress tau and a sliding surface is explained based on drawing 2 . Since the decomposition shearing stress tau is A/cosalpha for the area of a sliding surface and the component to the slip direction of external force is Fcosbeta, when the tension shaft of a sample makes alpha and beta, and the vertical section product of a sample A and external force F (sigma is normal stress F=sigmaA and here) for the normal of a sliding surface and a slip direction, and the angle to make, respectively, as shown in drawing 2 Tau=Fcosbeta/(A/cosalpha) =sigmacosalphacosbeta .... (1)
It is come out and expressed.
[0022] Next, when external force F acts on Si single crystal, it asks for |cosalphacosbeta| of the slip system which makes formula tau=Fcos beta/(A/cosalpha) =sigmacosalphacosbeta the maximum in 12 above-mentioned slip systems. Here, it is called the Schmid factor k and |cosalphacosbeta| of the slip system which makes tau the maximum is Dt about Dn and a slip direction in the direction of a normal of this sliding surface. If it carries out, the formula will be given as follows.
[0023]
[Equation 1]

$$k = \left| \frac{\mathbf{F} \cdot \mathbf{D_n}}{|\mathbf{F}| \cdot |\mathbf{D_n}|} \cdot \frac{\mathbf{F} \cdot \mathbf{D_t}}{|\mathbf{F}| \cdot |\mathbf{D_t}|} \right|$$

[0024] Next, the value of the Schmid factor k is concretely calculated about the silicon wafer shown in drawing 3 . The silicon wafer shown in drawing 3 shows the silicon wafer (a silicon wafer is only (100) called hereafter) which has the direction of the crystal face (100) in parallel with a wafer front face. And they are an axis of coordinates, xw, and yw in this silicon wafer side. It takes, it sets in the field of a silicon wafer, and is xw. The value of a Schmid factor in case external force F acts in the direction of a shaft and angle theta is calculated. Although it asks by the above-mentioned formula, since a Schmid factor changes with change of angle theta, if it shows the relation between an angle theta and the value of the Schmid factor k, it will become like drawing 4 .
[0025] The value of a Schmid factor is expressed with a period and a sine half-wave curve 45 degrees so that drawing 4 may show. The minimum value (theta.) = 45n and n= -- 0, 1, and -- 0.4082 -- it is -- moreover, maximum (theta.) = 45n+22.5 and n= -- it is 0.4928 in 0, 1, and -- Maximum takes a value larger about 21% than the minimum value so that it may understand from now on. Therefore, the decomposition shearing stress relevant to slip generating can be decreased about about twenty percent by changing the operation direction of external force (stress).
[0026] As mentioned above, theta whose value of a Schmid factor is the angle which takes the minimum value in case a silicon wafer (100) is supported with the silicon wafer supporter of a vertical-mold boat so that clearly. = Decomposition shearing stress can be decreased by supporting the position of 45n (n= 0, 1, 2, 3, 4, 5, 6, 7, 8). This state diagram is shown in drawing 7 (a). In addition, ten in drawing shows the silicon wafer and 11 shows the supporting point (supporter) of a silicon wafer.
[0027] Similarly, a Schmid factor k value is calculated about the silicon wafer shown in drawing 5 . The silicon wafer shown in drawing 5 shows the silicon wafer (a silicon wafer is only (111) called hereafter) which has the direction of the crystal face (111) in parallel with a wafer front face. And they are an axis of coordinates, xw, and yw in this silicon wafer side. It takes, it sets in the field of a silicon wafer, and is xw. The value of a Schmid factor in case external force F acts in the direction of a shaft and angle theta is calculated. Although it asks by the above-mentioned formula, since a Schmid factor changes with change of angle theta, if it shows the relation between an angle theta and the value of the Schmid factor k, it will become like drawing 6 .
[0028] The value of a Schmid factor is expressed with a period and a sine half-wave curve 30 degrees so that drawing 6 may show. The minimum value (theta.) = 30n and n= -- 0, 1, and -- 0.4082 -- it is -- moreover, maximum (theta.) = 30n+15 and n= -- it is 0.4714 in 0, 1, and -- Maximum takes a value larger about 15% than the minimum value so that it may understand from now on. Therefore, the decomposition shearing stress relevant to slip generating can be decreased about about 1.5 percent by changing the operation direction of external force (stress).
[0029] As mentioned above, in case a silicon wafer (111) is supported with the silicon wafer supporter of a vertical-mold boat so that clearly, decomposition shearing stress can be decreased by supporting the position of theta= 30n (n= 0, 1-12) whose value of a Schmid factor is the angle which takes the minimum value. This state diagram is shown in drawing 7 (b). In addition, ten in drawing shows the silicon wafer and 11 shows the supporting point (supporter) of a silicon wafer.
[0030] Moreover, what is necessary is just to support the silicon wafer supporter of a vertical-mold boat with the interval of 90 degrees which is the least common multiple (45 degrees and 30 degrees), in order

for a Schmid factor to support at the angle which takes the minimum value, without selecting both, in case a silicon wafer (100) and (111) a silicon wafer are supported with the silicon wafer supporter of a vertical-mold boat. in addition, although it was shown that what is necessary is just to support a wafer with 45 degrees and 30-degree interval in the above-mentioned example, the range of **5 times is included as tolerance of the well which does an almost equivalent effect so in the range of **5 times, and this angle

[0031]

[Effect of the Invention] According to the silicon wafer manner of support which was described above and which starts this invention like, the decomposition shearing stress relevant to slip generating can be decreased, it accumulates, crystal transposition does not arise in a silicon wafer, and a slip of a silicon wafer can be prevented. Consequently, while reducing the quality of a product, the effect of raising the yield of silicon wafer manufacture is done so.

[Translation done.]

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

TECHNICAL FIELD

[Industrial Application] this invention relates to the manner of support of the silicon wafer by the vertical-mold wafer boat for processing two or more semiconductor wafers with a vertical-mold heat treating furnace in more detail about the manner of support of a silicon wafer in the manufacturing process which heat-treats a silicon wafer.

[Translation done.]

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing 1 is drawing showing 12 slip systems of a silicon single crystal.
[Drawing 2] Drawing 2 is drawing in which pulling and showing the decomposition shearing stress in deformation.
[Drawing 3] Drawing 3 is drawing showing the silicon wafer which has the crystal face (100).
[Drawing 4] Drawing 4 is drawing showing the value of the Schmid factor of the silicon wafer which has the crystal face (100).
[Drawing 5] Drawing 4 is drawing showing the silicon wafer which has the crystal face (111).
[Drawing 6] Drawing 6 is drawing showing the value of the Schmid factor of the silicon wafer which has the crystal face (111).
[Drawing 7] it comes out, and it is and (b) of the silicon wafer whose drawing 7 shows one example of this invention and in which (a) has the crystal face (100) is drawing showing the support position of the silicon wafer which has the crystal face (111)
[Description of Notations]
10 Silicon Wafer
11 Supporter

[Translation done.]

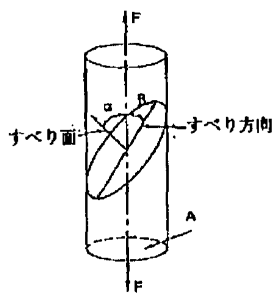
* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

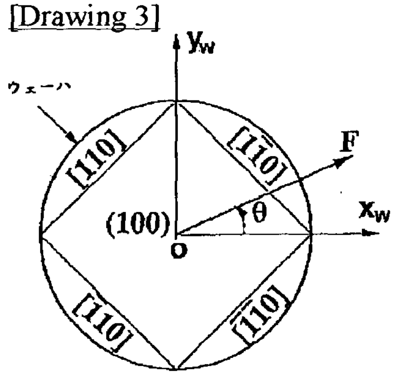
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

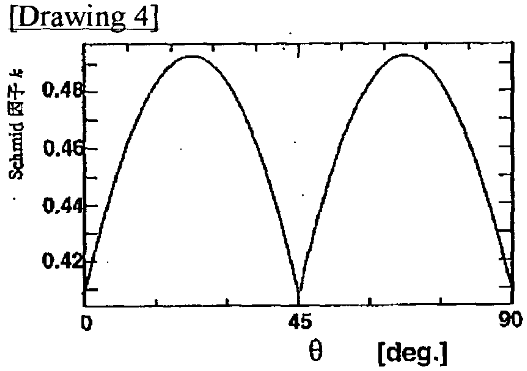
[Drawing 2]



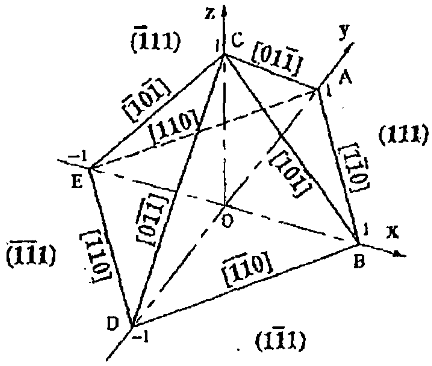
[Drawing 3]



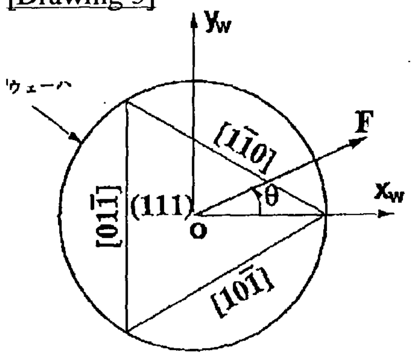
[Drawing 4]



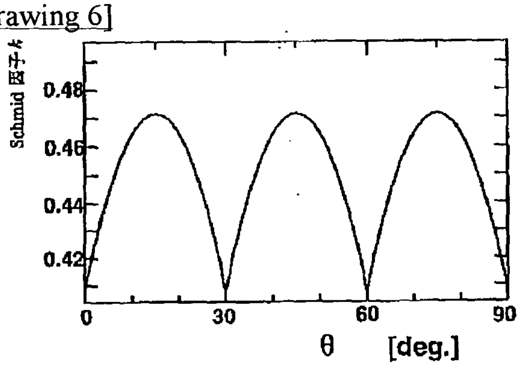
[Drawing 1]



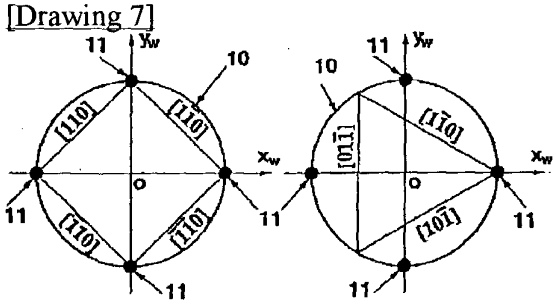
[Drawing 5]



[Drawing 6]



[Drawing 7]



(a) (100)ウェーハ (b) (111)ウェーハ

[Translation done.]